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(54) Title: METHOD FOR IMPROVING PLANT GROWTH BY APPLICATION OF A MIXTURE OF SULFUR AND COMPLEXING AGENT

(57) Abstract: Method for improving plant growth by application of a mixture M comprising a component a) of a1) 20 to 96% by weight of sulfur, a2) 4 to 80% by weight of a complexing agent and, if appropriate, one or more crop protectants b) and/or additives c).

Method for improving plant growth by application of a mixture of sulfur and complexing agent

The pr sent invention relates to a method for improving plant growth by application of a mixture M comprising a component a) of a1) 20 to 96% by weight of sulfur, a2) 4 to 80% by weight of a complexing agent and, if appropriate, one or more crop protection agents b) and/or further additives c); to the use of a polymeric cation complexing agent a2) for the preparation of a mixture comprising elemental sulfur for using this mixture as means for improving plant growth and to the use of a mixture M as means for improving plant growth, to an irrigation system encompassing A) a storage container filled with a mixture M, B) if appropriate a pump, C) a pipeline system which is connected to the storage container at the inlet position and which supplies one or more D) trickle systems and/or sprinklers at the outlet position(s), and to plantations encompassing useful plants and/or ornamentals, the soil and/or the substrate and the irrigation system as claimed as essential components.

Mixtures of sulfur with a variety of auxiliaries are known in the field of agriculture as fungicides or acaricides and commercially available for example as the product KUMULUS® from BASF Aktiengesellschaft.

However, the use of mixtures of elemental sulfur and complexing agents for improving plant growth is not known.

The use of lignosulfonate gel for soil conditioning is known from DE 198 28 483 A1, and the use of lignosulfonates in crop protection is known from WO 01/35747 A2.

What is known as trickle irrigation is extensively used for irrigating crop plants, for example, useful plants and/or ornamentals. In this system, nozzles which are supplied by a tank via a pipeline spray the nutrients and/or crop protectants, in general in aqueous solution, dispersion or suspension, into the vicinity of the plant roots. The nutrients and/or crop protectants are advantageously preblended in a storage tank which supplies the pipeline or spray nozzles. The leaves of the plants under cultivation do not come into contact with the nutrient and/or crop protectant solution in this method.

Trickle irrigation is frequently applied to alkaline soils or volcanic soils. Alkaline soils have the disadvantage that many plants do not grow well on them; according to current knowledge,

pH (approx. 8 and more, that is to say
t nutrients to be trapped in the soil;
taken up by the plant.

an be increased for example using zinc
from the costs involved, th disadvan-
at it leads to salinization of the soil,
nity of the roots of the useful plants,
ighly disadvantageous effect on plant
ization of the soil is increased by the
.

esent invention to develop a method or a
plant growth and the utilization of nu-
n alkaline or volcanic agricultural soil,
ion of the soil.

object is achieved by a method for im-
application of a mixture M comprising a
o 96% by weight of sulfur, a2) 4 to 80%
g agent and, if appropriate, one or more
) and/or further components c); by the
n complexing agent a2) for the prepara-
sing elemental sulfur, which mixture is
ing plant growth and by the use of a mix-
oving plant growth; by an irrigation sys-
orage container filled with a mixture M,
, C) a pipeline system which is connected
at the inlet position and which supplies
systems and/or sprinklers at the outlet
tations encompassing useful plants and/or
nd/or the substrate and the irrigation
sential components.

r present in the mixture according to the
al. Any elemental sulfur which has been
described in detail and commercially
The sulfur which can be obtained from nat-
an example of a suitable material.

r a1) in component a) according to the in-
of from 20 to 96% by weight, preferably
in particular 75 to 85% by weight, in
total weight of component a).

Suitable as complexing agents a2) are nonpolymeric complex-forming compounds, but preferably polymeric complex-forming compounds. The complexing agent a2) can comprise the pure complex-forming compounds, but also any mixtures of the pure compl x-forming compounds, the mixing ratio not being critical.

Suitable nonpolymeric complex-forming compounds are EDTA (ethylenediaminetetraacetic acid), NTA (nitrilotriacetic acid), EDDHA (ethylenediaminedi(ortho-hydroxyphenyl)acetic acid), DTPA (diethylenetriaminepentaacetic acid), HEDTA (hydroxyethylenediaminetriacetic acid), preferably ethylenediaminetetraacetic acid and/or diethylenetriaminepentaacetic acid.

Suitable polymeric complex-forming compounds are polyacrylic acid and its salts, in particular the sodium salts, polymethacrylic acid and its salts, in particular the sodium salts, polymaleic acid, prepared for example by hydrolyzing polymaleic anhydride, in particular the sodium salts, polyvinylpyrrolidone, acrylic acid/maleic acid copolymers, in particular the sodium salts, vinylpyrrolidone/vinyl acetate copolymers; graft copolymers of vinylpyrrolidone and C_{20}-α-olefin; vinylpyrrolidone/acrylic acid copolymers; vinylpyrrolidone/dimethylaminoethyl acrylate copolymers; methyl vinyl ether/maleic anhydride (derivative) copolymers; styrene/maleic anhydride copolymers; polyaspartic acid and its salts; poly-p-vinylbenzenesulfonic acid and its salts; copolymers of ethylene and/or propylene and/or isobutene and (meth)acrylic acid; modified starches, modified celluloses, for example carboxymethylcellulose; alginates; lignin derivatives such as lignosulfonates; chitosans; modified polysaccharides; phenolsulfonic acid/formaldehyde condensates; naphthalenesulfonic acid/formaldehyde condensates.

Polymeric complex-forming compounds a2) which are preferably employed are lignosulfonates; naphthalenesulfonic acid/formaldehyde condensates, polyacrylic acid and its salts, in particular the sodium salts; polymethacrylic acid and its salts, in particular the sodium salts; polymaleic acid or its salts, prepared for example by hydrolyzing polymaleic anhydride, in particular the sodium salts; acrylic acid/maleic acid copolymers, in particular the sodium salts; polyacrylates; polyaspartates and other polyamino acids. Polymeric complex-forming compounds which are used in particular are lignosulfonates and/or naphthalenesulfonic acid/formaldehyde condensates.

Lignosulfonates are known and are defined, for example, in Römpp Chemielexikon [Dictionary of Chemistry], 9th Edition, Volume 3, Georg-Thieme Verlag, Stuttgart, New York 1990, page 2511. Ligno-

sulfonates which are well suited are the alkali metal salts and/or alkaline earth metal salts and/or ammonium salts, for example the ammonium, sodium, potassium, calcium or magnesium salts of lignosulfonic acid. The sodium, potassium or calcium salts are preferably used, and the sodium and/or calcium salts are very particularly preferably used.

Naturally, the term lignosulfonates also encompasses mixed salts of different ions such as potassium/sodium lignosulfonate, potassium/calcium lignosulfonate or the like, in particular sodium/calcium lignosulfonate.

Naphthalenesulfonic acid/formaldehyde condensates are likewise known and commercially available for example as Tamol® products from BASF Aktiengesellschaft.

The amount of the cation complexing agent a2) in component a) according to the invention is in the range of from 4 to 80% by weight, preferably 5 to 30% by weight, in particular 15 to 25% by weight, in each case based on the total weight of component a).

If a mixture of lignosulfonate and naphthalenesulfonic acid/formaldehyde condensate is used as component a2), the lignosulfonate in this mixture generally amounts to in the range from 10 to 90% by weight and the naphthalenesulfonic acid/formaldehyde condensate in this mixture amounts to the complement in the range of from 90 to 10% by weight.

Components a) which are particularly well suited in accordance with the invention are those of 75 to 85% by weight of sulfur and 15 to 25% by weight of lignosulfonate.

Examples of components a) according to the invention are: 95% by weight sulfur + 5% by weight sodium lignosulfonate; 90% by weight sulfur + 10% by weight sodium lignosulfonate; 80% by weight sulfur + 20% by weight sodium lignosulfonate; 75% by weight sulfur + 25% by weight sodium lignosulfonate; 95% by weight sulfur + 5% by weight potassium lignosulfonate; 90% by weight sulfur + 10% by weight potassium lignosulfonate; 80% by weight sulfur + 20% by weight potassium lignosulfonate; : 95% by weight sulfur + 5% by weight calcium lignosulfonate; 90% by weight sulfur + 10% by weight calcium lignosulfonate; 80% by weight sulfur + 20% by weight calcium lignosulfonate.

The mixture M according to the invention, or component a), can be prepared by mixing, comminuting, drying, for example spray drying.

As a rule, the mixture M according to the invention, or component a), exists in flowable form as granular particles with a mean particle size - determined using the sieve analysis method as specified by CIPAC MT 170 (CIPAC Handbook F - Page 420 – Dry Sieve Analysis of Waterdispersible Granules) in the range of from 50 µm to 4 mm, preferably in the range of from 100 µm to 2 mm, whose primary particles are, as a rule, 0.05 to 8 µm in size (determined using ISO Method 13320-1: 1999 (Particle Size Analysis – Laser Diffraction Methods).

In addition to component a), the mixture M according to the invention can additionally comprise one or more crop protectants b) and/or further constituents c).

Crop protectants b) which are suitable are herbicides, pesticides and fungicides. Pesticides are understood as meaning, inter alia, acaricides, insecticides and nematicides.

Preferred herbicides, fungicides, acaricides, insecticides and nematicides can be seen from http://www.hclrss.demon.co.uk/index_cn_frame.html (Index of common names). A list of preferred herbicides, fungicides, acaricides, insecticides and nematicides is given hereinbelow, some of the active ingredients being mentioned several times with different "common names":

abamectin; acephate; acequinocyl; acetamiprid; acethion; acetochlor; acetoprole; acifluorfen; aclonifen; ACN; acrinathrin; acrolein; acrylonitrile; acypetacs; alachlor; alanap; alanycarb; aldicarb; aldimorph; aldoxycarb; aldrin; allethrin; d-trans-allethrin; allidochlor; allosamidin; alloxydim; allyl alcohol; allyxycarb; alorac; alpha-cypermethrin; ametridione; ametryn; ametryne; amibuzin; amicarbazone; amidithion; amidoflumet; amidosulfuron; aminocarb; aminotriazole; amiprofos-methyl; amiton; amitraz; amitrole; ammonium sulfamate; ampropylfos; AMS; anabasine; anilazine; anilofos; anisuron; arprocarb; arsenous oxide; asulam; athidathion; atraton; atrazine; aureofungin; avermectin B1; azaconazole; azadirachtin; azafenidin; azamethiphos; azidithion; azimsulfuron; azinphos-ethyl (= azinphosethyl); azinphos-methyl (= azinphosmethyl); aziprotryn (= aziprotryne); azithiram; azobenzene; azocyclotin; azothoate; azoxystrobin; barban (= barbanate); barium hexafluorosilicate; barium polysulfide; barium silicofluoride; barthrin; BCPC; beflubutamid; benalaxyl; benazolin; bendiocarb; bendioxide; benefin (= benfluralin); benfuracarb;

benfuresate; benodanil; benomyl; benoxafos; benquinox; bensulfuron; bensulide; bensultap; bentaluron; bentazon (= bentazone); benthiocarb; benzadox; benzalkonium chlorid ; b nzamacril; benzamizole; benzamorf; benzene hexachloride; benzfendizone; benzipram; benzobicyclon; benzoepin; benzofenap; benzofluor; benzohydroxamic acid; benzomate benzoximate (= benzoylprop); benzthiazuron; benzyl benzoate; beta-cyfluthrin; beta-cypermethrin; bethoxazin; BHC; gamma-BHC; bialaphos; bifenazate; bifenox; bifenthrin; bilanafos; binapacryl; bioallethrin; bioethanomethrin; biopermethrin; bioresmethrin; biphenyl; bispyribac; bistrifluron; bitertanol; bithionol; blasticidin-S; borax; Bordeaux mixture; BPPS; bromacil; bromchlophos; bromfenvinfos; bromobonil; bromobutide; bromocyclen; bromo-DDT; bromofenoxim; bromomethane; bromophos; bromophos-ethyl; bromopropylate; bromoxynil; brompyrazon; bromuconazole; BRP; bufencarb; bupirimate; buprofezin; Burgundy mixture; butacarb; butachlor; butafenacil; butam; butamifos; butathiofos; butenachlor; buthidazole; buthiobate; buthiuron; butocarboxim; butonate; butoxycarboxim; butralin; butroxydim; buturon; butylamine; butylate; butylchlorophos; cacodylic acid; cadusafos; cafenstrole; calcium arsenate; calcium chlorate; calcium cyanamide; calcium polysulfide; cambendichlor; camphechlor; captafol; captan; carbam; carbamorph; carbanolate; carbaryl; carbasulam; carbathion; carbendazim; carbetamide; carbofuran; carbon disulfide; carbon tetrachloride; carbophenothion; carbophos; carbosulfan; carboxazole; carboxin; carfentrazone; carpropamid; cartap; carvone; CDAA; CDEA; CDEC; CEPC; cerenox; cevadilla; Cheshunt mixture; chinalphos; chinalphos-méthyl; chinomethionat; chlobenthiazone; chlomethoxyfen; chlor-IPC; chloramben; chloraniformethan; chloranil; chloranocryl; chlorazifop; chlorazine; chlorbenside; chlorbicyclen; chlorbromuron; chlorbufam; chlordane; chlordecone; chlordimeform; chlorethoxyfos; chloreturon; chlorfenac; chlorfenapyr; chlorfenazole; chlorfenethol; chlorfenidim; chlorfénizon; chlorfenprop; chlorfenson; chlorfensulphide; chlorfenvinphos; chlorfenvinphos-methyl; chlorfluazuron; chlorflurazole; chlorflurecol; chlorflurenol; chloridazon; chlorimuron; chlorinate; chlormephos; chlormethoxynil; chlornitrofen; chloroacetic acid; chlorobenzilate; chloroform; chloromebuform; chloromethiuron; chloroneb; chlorophos; chloropicrin; chloropon; chloropropylate; chlorothalonil; chlorotoluron; chloroxifenidim (= chloroxuron); chloroxynil; chlorphoxim; chlorprazophos; chlorprocarb; chlorpropham; chlorpyrifos; chlorpyrifos-methyl; chlorquinox; chlorsulfuron; chlorthal; chlorthiamid; chlorthiophos; chlortoluron; chlozolinate; chromafenozide; cinerin I; cinerin II; cinidon-ethyl, cinmethylin; cinosulfuron; cisanilide; cismethrin; clethodim; climbazole; cliodinate; clodinafop; cloethocarb; clofentezine; clofop; clomazone; clomeprop; cloprop; cloproxydim; clopyralid; cloransulam; closantel; clothianidin; clo-

trimazole; CMA; CMMP; CMP; CMU; copper acetate; copper acetoarsenite; copper arsenate; copper carbonate, basic; copper hydroxide; copper naphthenate; copper oleate; copper oxychloride; copper 8-quinolinolate; copper silicate; copper sulfate; copper sulfate, basic; copper zinc chromate; coumaphos; coumithoate; 4-CPA; 4-CPB; CPMF; 4-CPP; CPPC; cresol (= cresylic acid); crotamiton; crotoxyfos (= crotoxyphos); crufomate; cryolite; cufraneb; cumyluron; cuprobam; cuprous oxide; CVMP; cyanatryn; cyanazine; cyanofenphos; cyanophos; cyanthoate; cyazofamid; cyclafuramid; cyclethrin; cycloate; cycloheximide; cycloprothrin; cyclosulfamuron; cycloxydim; cyflufenamid; cycluron; cyfluthrin; beta-cyfluthrin; cyhalofop; cyhalothrin; gamma-cyhalothrin; lambda-cyhalothrin; cyhexatin; cymoxanil; cypendazole; cypermethrin; alpha-cypermethrin; beta-cypermethrin; theta-cypermethrin; zeta-cypermethrin; cyperquat; cyphenothrin; cyprazine; cyprazole; cyprex; cyproconazole; cyprodinil; cyprofuram; cypromid; cyromazine; cythioate; 2,4-D; 3,4-DA; daimuron; dalapon; dazomet; 2,4-DB; 3,4-DB; DBCP; DCB; DCIP; DCPA (USA); DCPA (Japan); DCU; DDD; DDPP; DDT; pp (pure)-DDT; DDVP; 2,4-DEB; debacarb; decafentin; decarbofuran; dehydroacetic acid; deiquat; delachlor; delnav; deltamethrin; demephion; demephion-O; demephion-S; demeton; demeton-methyl; demeton-O; demeton-O-methyl; demeton-S; demeton-S-methyl; demeton-S-methylsulphon; (= demeton-S-methyl sulphone); DEP; 2,4-DEP; depalléthrine; derris; 2,4-DES; desmedipham; desmetryn (= desmetryne); diafenthiuron; dialifor (= dialifos); di-allate (= diallate); diamidafos; dianat; diazinon; dibrom; 1,2-dibromoethane; dicamba; dicapthon; dichlobenil; dichlofenthion; dichlofluanid; dichlone; dichloralurea; dichlorfenidim; dichlormate; o-dichlorobenzene (= ortho-dichlorobenzene); p-dichlorobenzene (= para-dichlorobenzene); 1,2-dichloroethane; dichloromethane; dichlorophen; 1,2-dichloropropane; 1,3-dichloropropene; dichlorprop; dichlorprop-P; dichlorvos; dichlozoline; diclobutrazol; diclocymet; diclofop; diclomezine; dicloran; diclosulam; dicofol; dicresyl; dicrotophos; dicryl; dicyclanil; dieldrin; dienochlor; diethamquat; diethatyl; diethion (= diéthion); diethofencarb; diethyl pyrocarbonate; difenoconazole; difenopenten; difenoxuron; difenzoquat; diflubenzuron; diflufenican (= diflufenicanil); diflufenzopyr; diflumetorim; dilor; dimefox; dimefuron; dimehypo; dimepiperate; dimetan; dimethachlor; dimethametryn; dimethenamid; dimethenamid-P; dimethirimol; dimethoate; dimethomorph; dimethrin; dimethylvinphos; dimetilan; dimexano; dimidazon; dimoxystrobin; dimpylate; dinex; diniconazole; diniconazole-M; dinitramine; dinobuton; dinocap; dinocap-4; dinocap-6; dinocton; dinofenate; dinopenton; dinoprop; dinosam; dinoseb; dinosulfon; dinotefuran; dinoterb; dinoterbon; diofenolan; dioxabenzofos; dioxacarb; dioxathion; diphenamid; diphenyl sulfone; diphenylamine; diphenylsulphide; dipropetryn; dipterex; dipyri-

thione; diquat; disugran; disul; disulfiram; disulfoton; ditalimfos; dithianon; dithicrofos; dithiométon; dithiopyr; diuron; dixanthogen; DMPA; DNOC; dodemorph; dodicin; dodine; dofenapyn; doguadine; doramectin (= 2,4-DP); 3,4-DP; DPC; drazoxolon; DSMA; d-trans-allethrin; dymron; EBEP; ecdysone; ecdysterone; echlomezol; EDB; EDC; EDDP (= edifenphos); eglinazine; emamectin; EMPC; empenthrin; endosulfan; endothal (= endothall); endothion; endrin; ephirsulfonate; EPN; epofenonane; epoxiconazole; eprinomectin; epronaz; EPTC; erbon; esfenvalerate; ESP; esprocarb; etaconazole; etaphos; etem; ethaboxam; ethalfluralin; ethametsulfuron; ethidimuron; ethiofencarb; ethiolate; ethion; ethiprole; ethirimol; ethoate-methyl; ethofumesate; ethoprop (= ethoprophos); ethoxyfen; ethoxyquin; ethoxysulfuron; ethyl pyrophosphate; ethylan (= ethyl-DDD); ethylene dibromide; ethylene dichloride; ethylene oxide; ethyl formate; ethylmercury acetate; ethylmercury bromide; ethylmercury chloride; ethylmercury phosphate; etinofen; ETM; etnipromid; etobenzanid; etofenprox; etoxazole; etridiazole; etrimfos; EXD; famoxadone; famphur; fenac; fenamidone; fenaminosulf; fenamiphos; fenapanil; fenarimol; fenasulam; fenazaflor; fenazaquin; fenbuconazole; fenbutatin oxide; fenchlorphos; fenethacarb; fenfluthrin; fenfuram; fenhexamid; fenidin; fenitropan; fenitrothion; fénizon; fenobucarb; fenolovo; fenoprop; fenothiocarb; fenoxacrim; fenoxanil; fenoxaprop; fenoxaprop-P; fenoxycarb; fenpiclonil; fenpirithrin; fenpropathrin; fenpropidin; fenpropimorph; fenpyroximate; fenridazon; fenson; fensulfothion; fenteracol; fenthiaprop; fenthion; fenthion-ethyl; fentiaprop; fentin; fentrazamide; fentrifanil; fenuron; fenvalerate; ferbam; ferimzone; ferrous sulfate; fipronil; flamprop; flamprop-M; flazasulfuron; flonicamid; florasulam; fluacrypyrim; fluazifop; fluazifop-P; fluazinam; fluazolate; fluazuron; flubenzimine; flucarbazone; fluchloralin; flucofuron; flucycloxuron; flucythrinate; fludioxonil; fluenetil; flufenacet; flufenerim; flufenican; flufenoxuron; flufenprox; flufenpyr; flumethrin; flumetover; flumetsulam; flumezin; flumiclorac; flumioxazin; flumipropyn; fluometuron; fluorbenside; fluoridamid; fluorochloridone; fluorodifen; fluoroglycofen; fluoroimide; fluoromidine; fluoronitrofen; fluothiuron; fluotrimazole; flupoxam; flupropacil; flupropanate; flupyrsulfuron; fluquinconazole; fluridone; flurochloridone; fluromidine; fluroxypyr; flurtamone; flusilazole; flusulfamide; fluthiacet; flutolanil; flutriafol; fluvalinate; tau-fluvalinate; folpel (= folpet); fomesafen; fonofos; foramsulfuron; formaldehyde; formetanate; formothion; formparanate; fosamine; fosetyl; fosmethilan; fospirate; fosthiazate; fosthietan; fthalide; fuberidazole; furalaxyl; furametpyr; furathiocarb; furcarbanil; furconazole; furconazole-cis; furethrin; furmecyclox; furophanate; furyloxyfen; gamma-BHC; gamma-cyhalothrin; gamma-HCH; glufosinate; glyodin; glyphosate; griseofulvin; guanoctine (= guazatine); ha-

lacrinate; halfenprox; halofenozide; halosafen; halosulfuron; haloxydine; haloxyfop; HCA; HCH; gamma-HCH; HEOD; heptachlor; heptenophos; heterophos; hexachlor (= hexachloran); hexachloroacetone; hexachlorobenzene; hexachlorobutadiene; hexaconazole; hexaflumuron; hexafluoramin; hexaflurate; hexazinone; hexylthiofos; hexythiazox; HHDN; hydramethylnon; hydrogen; cyanide; hydroprene; hydroxyisoxazole; 8-hydroxyquinoline; sulfate; hymexazol; hyquincarb; IBP; imazalil; imazamethabenz; imazamox; imazapic; imazapyr; imazaquin; imazethapyr; imazosulfuron; imibenconazole; imidacloprid; iminoctadine; imiprothrin; indanofan; indoxacarb; iodobonil; iodofenphos; iodosulfuron; ioxynil; ipazine; IPC; ipconazole; iprobenfos; iprodione; iprovalicarb; iprymidam; IPSP; IPX; isamidofos; isazofos; isobenzan; isocarbamid; isocil; isodrin; isofenphos; isomethiozin; isonoruron; isopolinate; isoprocarb; isoprocil; isopropalin; isoprothiolane; isoproturon; isothioate; isouron; isovaledione; isoxaben; isoxachlortole; isoxaflutole; isoxapyrifop; isoxathion; isuron; ivermectin; jasmolin I; jasmolin II; jodfenphos; juvenile hormone I; juvenile hormone II; juvenile hormone III; karbutilate; kasugamycin; kelevan; kinoprene; kresoxim-methyl; lactofen; lambda-cyhalothrin; lead arsenate; lenacil; leptophos; lime sulfur; d-limonene; lindane; linuron; lirimfos; lufenuron; lythidathion; M-74; M-81; MAA; malathion; maldison; malonoben; MAMA; mancopper; mancozeb; maneb; mazidox; MCC; MCPA; MCPA-thioethyl; MCPB; 2,4-MCPB; mebenil; mecarbam; mecarbinzid; mecarphon; mecoprop; mecoprop-P; medinoterb; mefenacet; mefluidide; menazon; MEP; mepanipyrim; mephosfolan; mepronil; mercaptodimethur; mercaptophos; mercaptophos-teolevy; mercaptothion; mercuric chloride; mercuric oxide; mercurous chloride; mesoprazine; mesosulfuron; mesotrione; mesulfen; mesulfenfos; mesulphen; metalaxyl; metalaxyl-M; metam; metamitron; metaphos; metaxon; metazachlor; metazoxolon; metconazole; metflurazon; methabenzthiazuron; methacrifos; methalpropalin; metham; methamidophos; methasulfocarb; methazole; methfuroxam; methibenzuron; methidathion; methiobencarb; methiocarb; methiuron; methocrotophos; métholcarb; methometon; methomyl; methoprene; methoprotryn; methoprotryne; methoxychlor; 2-methoxyethylmercury chloride; methoxyfenozide; methyl bromide; methylchloroform; methyldithiocarbamic acid; methyldymron; methylene chloride; methyl isothiocyanate; methyl-mercaptophos; methylmercaptophos oxide; methyl-mercaptophos-teolevy; methylmercury benzoate; methylmercury dicyandiamide; methyl parathion; methyltriazothion; metiram; metobenzuron; metobromuron; metolachlor; S-metolachlor; metolcarb; metominostrobin; metosulam; metoxadiazone; metoxuron; metrafenone; metribuzin; metriphonate; metsulfovax; metsulfuron; mevinphos; mexacarbate; milbemectin; milneb; mipafox; MIPC; mirex; MNAF; molinate; monalide; monisouron; monochloroacetic acid; monocrotophos; monolinuron; monosulfiram; monuron; morfamquat;

morphothion; MPMC; MSMA; MTMC; myclobutanil; myclozolin; nabam; naftalofos; naled; naphthalene; naphthalic anhydride; naphthalophos; naproanilide; napropamide; naptalam; natamycin; neburea; neburon; nendrin; nichlorfos; niclofen; niclosamide; nicobifen; nicosulfuron; nicotin ; nifluridide; nikkomycins; NIP; nipyraclofen; nitenpyram; nithiazine; nitralin; nitrapyrin; nitrilacarb; nitrofen; nitrofluorfen; nitrostyrene; nitrothal-isopropyl; nobormide; norbormide; norea; norflurazon; noruron; novaluron; noviflumuron; NPA; nuarimol; OCH; octhilinone; o-dichlorobenzene; ofurace; omethoate; orbencarb; orthobencarb; ortho-dichlorobenzene; oryzalin; ovatron; ovex; oxadiargyl; oxadiazon; oxadixyl; oxamyl; oxapyrazon; oxasulfuron; oxaziclomefone; oxine-copper; oxine-Cu; oxpoconazole; oxycarboxin; oxydemeton-methyl; oxydeprofos; oxydisulfoton; oxyfluorfen; oxythioquinox; PAC; palléthrine; PAP; para-dichlorobenzene; parafluron; paraquat; parathion; parathion-methyl; Paris green; PCNB; PCP; p-dichlorobenzene; pebulate; pédinex; pefurazoate; penconazole; pencycuron; pendimethalin; penfluron; penoxsulam; pentachlorophenol; pentanochlor; pentoxazone; perfluidone; permethrin; pethoxamid; PHC; phénétacarbe; phenisopham; phenkapton; phenmedipham; phenmedipham-ethyl; phenobenzuron; phenothiol; phenothrin; phenthoate; phenylmercuriurea; phenylmercury acetate; phenylmercury chloride; phenylmercury nitrate; phenylmercury salicylate; 2-phenylphenol; phorate; phosalone; phosdiphen; phosfolan; phosmet; phosnichlor; phosphamide; phosphamidon; phosphine; phosphocarb; phoxim; phoxim-methyl; phthalide; phthalophos; phthalthrin; picloram; picolinafen; picoxystrobin; piperophos; pirimetaphos; pirimicarb; pirimiphos-ethyl; pirimiphos-methyl; PMA; PMP; polycarbamate; polychlorcamphene; polyethoxyquinoline; polyoxins; polyoxorim; potassium arsenite; potassium cyanate; potassium polysulfide; potassium thiocyanate; pp-DDT (pure); prallethrin; precocene I; precocene II; precocene III; pretilachlor; primidophos; primisulfuron; probenazole; prochloraz; proclonol; procyazine; procymidone; prodiamine; profenofos; profluazol; profluralin; profoxydim; proglinazine; promacyl; promecarb; prometon; prometryn; prometryne; pronamide; propachlor; propafos; propamocarb; propanil; propaphos; propaquizafop; propargite; propazine; propetamphos; propham; propiconazole; propineb; propisochlor; propoxur; propoxycarbazone; propyzamide; prosulfalin; prosulfocarb; prosulfuron; prothidathion; prothiocarb; prothiofos; prothoate; protrifenbute; proxan; prymidophos; prynachlor; pydanon; pyracarbolid; pyraclofos; pyraclonil; pyraclostrobin; pyraflufen; pyrazolate; pyrazolynate; pyrazon; pyrazophos; pyrazosulfuron; pyrazoxyfen; pyresmethrin; pyrethrin I; pyrethrin II; pyrethrins; pyribenzoxim; pyributicarb; pyriclor; pyridaben; pyridafol; pyridaphenthion; pyridate; pyridinitril; pyrifenox; pyriftalid; pyrimétaphos; pyrimethanil; pyrimicarbe; pyrimidifen; pyrimitate; pyriminobac; pyrimiphos-

éthyl; pyrimiphos-méthyl; pyriproxyf n; pyrithiobac; pyroquilon; pyroxychlor; pyroxyfur; quassia; quinacetol; quinalphos; quinalphos-methyl; quinazamid; quinclorac; quinconazole; quinmerac; quinoclamine; quinomethionate; quinonamid; quinothion; quinoxyfen; quintiofos; quintozene; quizalofop; quizalofop-P; rabenzazole; rafoxanide; reglone; resmethrin; rhodethanil; rimsulfuron; rodéthanil; ronnel; rotenone; ryania; sabadilla; salicylanilide; schradan; sebuthylazine; secbumeton; selamectin; sesone; sethoxydim; sevin; siduron; silafluofen; silthiofam; silvex; simazine; simeconazole; simeton; simetryn; simetryne; SMA; sodium arsenite; sodium chlorate; sodium fluoride; sodium hexafluorosilicate; sodium orthophenylphenoxide; sodium pentachlorophenate; sodium pentachlorophenoxide; sodium o-phenylphenoxide; sodium polysulfide; sodium silicofluoride; disodium tetraborate; sodium thiocyanate; solan; sophamide; spinosad; spirodiclofen; spiroxamine; stirofos; streptomycin; sulcofuron; sulcotrione; sulfallate; sulfentrazone; sulfiram; sulfluramid; sulfometuron; sulfosulfuron; sulfotep; sulfotepp; sulfur; sulfuric acid; sulfuryl fluoride; sulglycapin; sulprofos; sultropen; swep; 2,4,5-T; tau-fluvalinate; tazimcarb; 2,4,5-TB; 2,3,6-TBA; TBTO; TBZ; TCA; TCBA; TCMTB; TCNB; TDE; tebuconazole; tebufenozide; tebufenpyrad; tebupirimfos; tebutam; tebuthiuron; tecloftalam; tecnazene; tecoram; tedion; teflubenzuron; tefluthrin; temephos; TEPP; tepraloxydim; terallethrin; terbacil; terbucarb; terbuchlor; terbufos; terbumeton; terbuthylazine; terbutol; terbutryn; terbutryne; terraclor; tetrachloroethane; tetrachlorvinphos; tetraconazole; tetradifon; tetradisul; tetrafluron; tetramethrin; tetranactin; tetrasul; thenylchlor; theta-cypermethrin; thiabendazole; thiacloprid; thiadiazine; thiadifluor; thiamethoxam; thiameturon; thiazafluron; thiazone; thiazopyr; thicrofos; thicyofen; thidiazimin; thidiazuron; thifensulfuron; thifluzamide; thiobencarb; thiocarboxime; thiochlorfenphim; thiochlorphenphime; thiocyclam; thiodan; thiodicarb; thiofanocarb; thiofanox; thiomersal; thiometon; thionazin; thiophanate; thiophanate-ethyl; thiophanate-methyl; thiophos; thioquinox; thiosultap; thiram; thiuram; thuringiensin; tiabendazole; tiocarbazil; tioclorim; tioxymid; TMTD; tolclofos-methyl; tolylfluanid; tolfenpyrad; tolylmercury acetate; toxaphene; 2,4,5-TP; 2,3,3-TPA; TPN; tralkoxydim; tralomethrin; d-trans-allethrin; transfluthrin; transpermethrin; tri-allate; triadimefon; triadimenol; triallate; triamiphos; triarathene; triarimol; triasulfuron; triazamate; triazbutil; triaziflam; triazophos; triazothion; triazoxide; tribenuron; tributyltin oxide; tricamba; trichlamide; trichlorfon; trichlormetaphos-3; trichloronat; trichloronate; trichlorphon; triclopyr; tricyclazole; tricyclohexyltin hydroxide; tridemorph; tridiphane; trietazine; trifenofos; trifloxystrobin; trifloxysulfuron; triflumizole; triflumuron; trifluralin; triflusulfuron; trifop; trifopsime; triforine; trimeturon; tri-

phenyltin; triprene; tripropindan; tritac; triticonazol ; tritosulfuron; uniconazole; uniconazole-P; validamycin; vamidothion; vaniliprole; vernolate; vinclozolin; XMC; xylachlor; xylenols; xylylcarb; zarilamid; zeta-cypermethrin; zinc naphthenate; zineb; zolaprofos; zoxamide trichlorophenat ; 1,2-dichloropropane; 1,3-dichloropropene; 2-methoxyethylmercury chloride; 2-phenylphenol; 2,3,3-TPA; 2,3,6-TBA; 2,4-D; 2,4-DB; 2,4-DEB; 2,4-DEP; 2,4-DP; 2,4-MCPB; 2,4,5-T; 2,4,5-TB; 2,4,5-TP; 3,4-DA; 3,4-DB; 3,4-DP; 4-CPA; 4-CPB; 4-CPP; 8-hydroxyquinoline sulfate.

Naturally, the crop protectants b) may also be present as a mixture in the usual mixing ratios. The amount of crop protectant b), based on the amount of component a), is usually 1 to 25% by weight, preferably 3 to 15% by weight.

The crop protectant b) need not be present readily mixed with the components a) and, if appropriate, c), but may also be admixed before the components a) and, if appropriate, c) are applied, for example as what is known as tank mix.

Preferred crop protectants b) are soil-acting agents such as acetochlor, alachlor, aldicarb, asulam, atrazine, benalaxyl, bendiocarb, benfuracarb, benomyl, benthiocarb, borax, bromacil, butachlor, butam, cadusafos, calcium cyanamide, captafol, captan, carbaryl, carbendazim, carbofuran, carbon disulfide, carbon tetrachloride, carbosulfan, carboxin, CDAA, CDEA, CDEC, CEPC, chlor-IPC, chloramben, chlorbromuron, chlordane, chlorfluazuron, chloridazon, chloropicrin, chlorothalonil, chlorotoluron, chloroxifenidim (= chloroxuron), chlorpropham, copper acetate, copper acetoarsenite, copper arsenate, copper carbonate, basic, copper hydroxide, copper naphthenate, copper oleate, copper oxychloride, copper 8-quinolinolate, copper silicate, copper sulfate, basic copper zinc chromate, cyanazine, dalapon, dazomet, decarbofuran, di-allate (= diallate), diazinon, dibrom, 1,2-dibromoethane, dichlobenil, 1,2-dichloroethane, dichloromethane, 1,2-dichloropropane, 1,3-dichloropropene, dieldrin, diphenamid, dipterex, diuron, endosulfan, endrin, epoxiconazole, EPTC, ethalfluralin, ethylan (= ethyl-DDD), ethylene dibromide, ethylene dichloride, ethylene oxide, ethylmercury bromide, ethylmercury chloride, ethylmercury phosphate, fenuron, ferbam, ferrous sulfate, fluchloralin, folpel (= folpet), formaldehyde, fosthiazate, furmecyclox, gamma-BHC, gamma-cyhalothrin, gamma-HCH, guanoctine (= guazatine), HCH, gamma-HCH, heptachlor, hexachlor, hydrogencyanide, imazalil, imazamox, imazapic, imazapyr, imazaquin, imazethapyr, imazosulfuron, imidacloprid, IPC, iprodione, isonoruron, isoprocarb, isoproturon, isouron, lactofen, lenacil, lime sulfur, lindane, linuron, mancopper, mancozeb, maneb, mercuric chloride,

mercuric oxide, mercurous chloride, metalaxyl, metalaxyl-M, metam, metazachlor, methabenzthiazuron, metham, methyl bromide, methylchloroform, isothiocyanate, methyl-mercaptophos, methylmercaptophos, methylmercury benzoate, methylmercury, metiram, metobenzuron, metobromuron, metolachlor, S-metolachlor, metosulam, metoxuron, metribuzin, mirex, molinate, monalide, monolinuron, monuron, MSMA, nabam, naled, naphthalic anhydride, napropamide, naptalam, neburea, neburon, nitralin, norflurazon, noruron, novaluron, ofurace, oryzalin, oxadixyl, oxine-copper, oxine-Cu, oxycarboxin, PCNB, PCP, pebulate, pendimethalin, phenylmercuriurea, phenylmercury acetate, phenylmercury chloride, phenylmercury nitrate, phenylmercury salicylate, phorate, phosphocarb, phthalide, phthalophos, phthalthrin, picloram, pirimicarb, potassium arsenite, potassium cyanate, potassium polysulfide, potassium thiocyanate, prochloraz, procymidone, profluralin, propham, propiconazole, propineb, prosulfalin, pyrazon, quinclorac, sevin, siduron, simazine, sulfur, sulfuric acid, tebuconazole, terbacil, terraclor, thiabendazole, thiacloprid, thiameturon, thiobencarb, thiocarboxime, thiodan, thiodicarb, thiofanocarb, thiophanate, thiophanate-ethyl, thiophanate-methyl, thiram, thiuram, tiabendazole, TMTD, toxaphene, tri-allate, triadimefon, triadimenol, triallate, tribenuron, hydroxide, triflumuron, trifluralin, vernolate, vinclozolin, zineb, 1,2-dichloropropane, 1,3-dichloropropene.

Further suitable components c) in the mixture M are: water in minor amounts, for example 1 to 6% by weight based on component a), fillers, water softeners and the additives conventionally used in the agricultural sector in usual amounts, for example plant nutrients in the various forms, and furthermore fillers such as kaolin clay, bentonite, talc, calcium carbonate; anticaking agents such as finely divided silicas; soluble salts such as sodium chloride, sodium sulfate, ammonium sulfate; surfactants such as alkyl sulfates, alkylsulfonates, alkyl polyglycosides, alkyl ether sulfates, alkylbenzenesulfonates, alkylsuccinic ester sulfonates, alkyl esters of mono/diphosphoric acid, sarcosinates, taurates, alkoxylated animal/vegetable fats and oils, glycerol esters, alkoxylated fatty alcohols and oxo alcohols, alkoxylated fatty acids, alkylphenol ethoxylates, fatty amine alkoxylates, fatty acid amide alkoxylates, sugar surfactants such as sorbitan fatty acid esters and their ethoxylates, ethylene oxide/propylene oxide block polymers; antifoams, such as silicone surfactants.

The mixture M according to the invention can be used or applied in practice in dry form, for example in pure form, or as formulation, or else in a liquid medium.

Suitable liquid media are: aqueous salt solutions, aqueous nutrient solutions (for example made of nutrient salts and/or ureas), in particular water.

As a rule, the mixture M according to th invention is employed in an aqueous medium, in particular water, in a concentration range of from 0.0001 to 6% by weight, preferably 0.001 to 0.01% by weight, in particular 0.0015 to 0.005% by weight, based on the total weight of mixture M according to the invention and medium.

The mixtures M according to the invention can be sold commercially in different types of formulation. Suitable types of formulation are liquid suspension concentrates, solid water-dispersible powders, water-dispersible granules and granules for broadcasting. Water-dispersible granules are preferred.

The total application rate of the mixtures M according to the invention differs markedly from the total application rate of a comparable (for example commercial) mixture for pure crop protection purposes, for example in the application of fungicides, in comparable crops. When used purely for crop protection purposes, the total application rate, for example when using the product Kumulus DF from BASF Aktiengesellschaft, is usually in the range of from 5 to 50 kg/(ha, crop, season). When used according to the invention as soil conditioner, a total application rate of more than 50 and up to 5000 kg/(ha, crop, season) of the mixture M is usually used, preferably a total application rate of more than 50 and up to 500 kg/(ha, crop, season) of the mixture M.

The method according to the invention can be applied to all soils and/or substrates (growth media, for example rockwool) on which useful plants and/or ornamentals are usually produced; neutral to alkaline soils and/or substrates, including volcanic soils, are preferred. Neutral to alkaline soils and/or substrates are to be understood as meaning, for the present purpose, those whose pH is in the range of from 6.2 to 9.0, preferably 7.0 to 8.2.

The method according to the invention can be carried out with all customary irrigation systems or irrigation methods which are described, for example, in Antonio L. Alarcon, "tecnologia para cultivos de alto rendimiento" [Technology for high-yielding cultivars], Ed.: NOVEDADES AGRICOLAS S.A. Torre Pacheco (Murcia), 2000 (ISBN: 84-607-1212-5) or in Yaron, B; Danfors, E and Vaadia, Y.: Arid zone irrigation (1973, Springer Verlag; chapter 'Irrigation Technology', pp. 303-353, for example overhead irrigation, canal irrigation, flooding, pivot irrigation; preferred are, however, those irrigation systems or irrigation methods which ensure

irrigation of the soil or substrate underneath the edge of the plants' canopy, such as trickl irrigation or micro-sprinkler irrigation, which are known.

A particular advantage of the mixture M according to the invention is that it is readily dispersible (suspendible) for example in water, that is to say that the mixture according to the invention does not settle in the aqueous dispersion (suspension) within foreseeable periods and/or, for example, separates at the surface ("creaming"). A good measure for this dispersibility (suspendibility) is the suspension stability as defined in CIPAC MT 168 (CIPAC Handbook F - Page 427 – Determination of Suspension Stability of Waterdispersible Granules). Usually, the suspension stability of the aqueous dispersions (suspensions) which comprise the mixture M according to the invention is 50 to 100%, preferably 70 to 100%.

The irrigation system according to the invention, preferably the trickle irrigation system, encompasses A) a storage container filled with the mixture M according to the invention, B) if appropriate a pump which supplies the pipeline system C), C) a pipeline system which is connected to the storage container at the inlet position and which supplies one or more D) trickle systems and/or sprinklers at the outlet position(s).

The plantations according to the invention encompass the useful plants and/or ornamentals, the soil and/or the substrate and the above-described irrigation system according to the invention, preferably trickle irrigation system, as essential components.

Suitable useful plants are arable crops such as cotton or cereals, but preferably fruit and vegetable plantings, preferably perennial plantings. Suitable ornamentals are potted plants and cut flowers, preferably perennial crops such as roses. Examples of fruit and vegetable plantings are: tomatoes, bell peppers, cucumbers, citrus fruit, bananas, peaches, dessert grapes, apples, pears, olives, mangoes, pawpaws, avocados, strawberries or kiwi fruit.

The method according to the invention and the devices according to the invention are distinguished in particular by the fact that the growth of the plants and their content of utilizable substances is increased in particular on alkaline soil under cultivation or volcanic soils, avoiding salinization of the soil in the process. The use of the mixture according to the invention promotes the growth of the plants more than when the constituents of the mixture M are applied by themselves (for example sulfur

and sodium lignosulfonate in qual application rates. This effect manifests itself for example in the plant fresh-matter yield or in the iron and manganese content in the plant. This is in each case the result of a synergistic effect of the mixture M according to the invention, and the pH of the soil was not detectably altered by the treatment. It is furthermore surprising that the total salt content in the treated soil (determined by measuring the electrical conductivity) is markedly reduced. The mixture M according to the invention can be employed readily in irrigation systems, in particular for trickle irrigation. The medium can be pumped readily, inter alia because the ultrafinely particulate mixture M according to the invention is thoroughly dispersed/suspended in the aqueous mixture, and does not lead to blocking of the irrigation pipeline system or its nozzles or valves, as is the case for example in the case of coarsely-particulate suspended solids.

Examples

Synergism sulfur – sodium lignosulfonate in the fertigation of plants

Experimental set-up: Container experiment with Chinese leaves

Combinations:

1. without addition
2. 8 mg S/pot/week
3. 80 mg S/pot/week
4. 2 mg sodium lignosulfonate/pot/week
5. 20 mg sodium lignosulfonate/pot/week
6. 10 mg mixture of 80% by weight sulfur and 20% by weight sodium lignosulfonate/pot/week
7. 100 mg mixture of 80% by weight sulfur and 20% by weight sodium lignosulfonate/pot/week

Method:

Plant species:
Chinese leaves "Kasumi", sown into P-soil in multi-cell trays, age at pricking out time into experimental containers: approx. 14 days; the same containers are planted twice.

Substrate:
Soil from Ruchheim, loam, pH 7.4, mixed with quartz sand (for retaining the structural stability during the container experiment).

Container:
PE pots/15, approx. 1 l substrate (1.5 kg).

Location:
Greenhouse, 25 °C, supplementary lighting suitable for assimilation.

Fertilization:
Plant food 15+10+15+2 with trace elements without chelating agent (LAB 2411D; 0.5 g/container/week).

Irrigation:
Using a syringe and cannula into the soil at a depth of approx. 1 cm to simulate trickle irrigation conditions.

The additions were applied in one application weekly via the cannula. 10 mg of mixture M according to the invention/container/week correspond to approx. 5 kg/ha.

Results

Growth:

Growth promotion by increasing additions of lignosulfonate or of the mixture M according to the invention are observed, in particular in the first batch of plants. The addition of sulfur had no growth-promoting effect. The effect of the mixture M according to the invention tends to be superior to the effect of sodium lignosulfonate

It was therefore necessary to test whether the effect of the mixture M according to the invention took the form of an additive effect of the two individual components or else of a synergistic effect. It can be seen clearly from the evaluation in table 1 that a synergistic effect was observed in each case, since the arithmetical growth performance to be expected ("expected") is always lower than the actual growth recorded.

Nutrient contents:

The N, P, K and Mg contents were virtually not affected by the additional application of the components (table 2). In contrast, the contents in the trace elements iron (Fe) and manganese (Mn) increased markedly.

Again, a statistical check revealed that the increased contents were obtained by a synergistic effect of the individual components in the mixture M according to the invention (table 3).

Soil pH

The soil pH values were determined in soil samples which were taken firstly next to the trickler and secondly opposite. The sampling depth in the soil was approx. 3 cm, and the auger had a diameter of approx. 1 cm.

It can be seen from the list of the pH values in table 4 that the treatment had virtually no effect on the pH, both next to the trickler and opposite.

The results from the soil analysis which are compiled in table 5 show that the total salt contents in the soil are markedly reduced in virtually all of the samples owing to the use of the mixture M according to the invention. According to present knowledge, a reduced salt content has a positive effect on plant growth since the water balance for the plant is improved. The decrease is particularly pronounced in the important top-most soil stratum, which is where most of the plant roots are located. The decreased salt content is also reflected in reduced concentrations of sodium ions, which are particularly harmful to plants and also sulfate ions in the soil water.

Table 1

Testing a synergistic effect of the mixture M (80% by weight sulfur + 20% by weight sodium lignosulfonate) on the growth of Chinese leaves

Treatment	Fresh-matter yield		Expected value (Colby)(E)	Reading (R)
	g/container	% of untreated		
Plant batch 1				
Untreated	109	100	-	-
Sulfur 8 mg	106	97	-	-
Lignosulfonate 2 mg	112	103	-	-
Mixture M 10 mg	115	105	99	105
Sulfur 80 mg	108	99	-	-
Lignosulfonate 20 mg	117	104	-	-
Mixture M 100 mg	118	108	104	108
Plant batch 2				
Untreated	70	100	-	-
Sulfur 8 mg	67	96	-	-
Lignosulfonate 2 mg	76	108	-	-
Mixture M 10 mg	83	118	103	108
Sulfur 80 mg	68	97	-	-
Lignosulfonate 20 mg	79	112	-	-
Mixture M 100 mg	77	110	108	110

Expected value E < reading R = synergistic effect

Table 2

Mineral contents in leaves of Chinese leaves after application of the mixture M according to the invention (80% by weight sulfur + 20% by weight sodium lignosulfonate) and individual components

	N	P	K	Mg	Mn	Fe
	% in DM				ppm in DM	
Plant batch 1						
Without	3.76	0.48	4.45	0.25	65	110
S 8 mg	3.57	0.46	5.23	0.24	66	140
S 80 mg	3.86	0.50	5.57	0.25	67	174
Lignosulfonate 2 mg	3.60	0.45	4.09	0.23	64	129
Lignosulfonate 20 mg	3.64	0.44	4.05	0.23	59	94
Mixture M 10 mg	3.47	0.44	4.38	0.24	71	249
Mixture M 100 mg	3.69	0.50	4.47	0.26	91	255

Table 3

Testing a synergistic effect of the mixture M according to the invention (80% by weight sulfur + 20% by weight sodium lignosulfonate) on the iron and manganese contents in Chinese leaves (plant batch 1)

Treatment	Content in		Expected value (Colby) (E)	Reading (R)
	ppm	% of untreated		
Manganese				
Untreated	65	100	-	-
Sulfur 8 mg	66	101	-	-
Lignosulfonate 2 mg	64	99	-	-
Mixture M 10 mg	71	109	100	109
Sulfur 80 mg	67	103	-	-
Lignosulfonate 20 mg	59	91	-	-
Mixture M 100 mg	91	140	94	140
Iron				
Untreated	110	100	-	-
Sulfur 8 mg	140	127	-	-
Lignosulfonate 2 mg	129	117	-	-
Mixture M 10 mg	249	226	149	226
Sulfur 80 mg	174	158	-	-
Lignosulfonate 20 mg	94	85	-	-
Mixture M 100 mg	255	231	134	231

Expected value E < reading R = synergistic effect

Table 4

pH values in the substrate with Chinese leaves after application of the mixture M according to the invention (80% by weight sulfur + 20% by weight sodium lignosulfonate) and individual components

	pH	
	Next to trickler	Opposite trickler
After plant batch 1		
Untreated	7.05	7.58
Sulfur 8 mg	7.11	7.66
Lignosulfonate 2 mg	7.14	7.73
Mixture M 10 mg	7.11	7.78
Sulfur 80 mg	7.18	7.76
Lignosulfonate 20 mg	7.18	7.78
Mixture M 100 mg	7.11	7.78
After plant batch 2		
Sulfur 8 mg	6.41	7.26
Lignosulfonate 2 mg	6.39	7.32
Mixture M 10 mg	6.29	7.21
Sulfur 80 mg	6.46	7.38
Lignosulfonate 20 mg	6.48	7.45
Mischung M 100 mg	6.39	7.44

Table 5

Salt contents in the soil at different depths after addition of the mixture M according to the invention (80% by weight sulfur + 20% by weight sodium lignosulfonate) in the fertigation during the growth period of tomatoes

Date	Soil depth in cm	Salt content µS/cm* Mixture M		Na^+ mg/l Mixture M		SO_4^- mg/l Mixture M	
		without	with	without	with	without	with
16.10.	30	17 210	8 890	808	538	1 899	1 214
	60	-	10 400	-	840	-	2 440
30.10.	30	6 180	3 980	534	424	1 357	1 072
	60	7 400	7 910	623	554	1 860	1 590
13.11.	30	5 160	3 380	529	380	1 637	1 104
	60	4 780	4 590	524	738	1 172	1 460
28.11.	30	3 470	2 760	-	-	-	-
	60	-	7 820	-	-	-	-
16.12.	30	3 560	3 100	-	-	-	-
	60	4 340	3 980	-	-	-	-
29.12.	30	4 340	3 230	-	-	-	-
	60	3 940	3 600	-	-	-	-

*) electrical conductivity

We claim:

1. A method for improving plant growth by application of a mixture M comprising a component a) of

a1) 20 to 96% by weight of sulfur,

a2) 4 to 80% by weight of a complexing agent

and, if appropriate, one or more crop protection agents b) and/or further additives c).

2. A method as claimed in claim 1, wherein the complexing agent a2) comprises a polymeric complex-forming compound.

3. A method as claimed in claim 1 or 2, wherein the polymeric complexing agent a2) is a lignosulfonate, a naphthalenesulfonic acid/formaldehyde condensate or a mixture of lignosulfonate and naphthalenesulfonic acid/formaldehyde condensate.

4. A method as claimed in any of claims 1 to 3, wherein the polymeric complexing agent a2) is an alkali metal lignosulfonate and/or alkaline earth metal lignosulfonate.

5. A method as claimed in any of claims 1 to 4, wherein application is effected on neutral to basic soils and/or substrates.

6. A method as claimed in any of claims 1 to 5, wherein the mixture M is flowable and has a mean particle size of 50 µm to 4 mm.

7. A method as claimed in claims 1 to 6, wherein application is effected using a trickle irrigation device.

8. The use of a polymeric cation complexing agent a2) - as defined in claims 1 to 4 - for the preparation of a mixture comprising elemental sulfur, which mixture is used as means for improving plant growth.

9. The use of a mixture M - as defined in claims 1 to 4 - as means for improving plant growth.

10. An irrigation system encompassing A) a storage container fill d with a mixture M - as defined in claims 1 to 4 -, B) if appropriate a pump, C) a pipeline system which is connected to the storage container at the inlet position and which supplies one or more D) trickle systems and/or sprinklers at the outl t position(s).

11. Plantations encompassing useful plants and/or ornamentals, the soil and/or the substrate and the irrigation system as claimed in claim 10 as essential components.

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP 02/08501

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C05D9/00 C05F11/00 C05G5/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 C05D C05G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 2 292 140 A (HAYS CHEM DISTR LTD) 14 February 1996 (1996-02-14) claims 1,3,11,12 page 4, paragraphs 2,3	1-6,8,9
X	US 4 676 821 A (GULLETT LARRY L ET AL) 30 June 1987 (1987-06-30) claims 1,9,12	1-6,8,9
X	US 2 683 658 A (SAUNDERS HAROLD F ET AL) 13 July 1954 (1954-07-13) claims column 1, line 1 - line 10 column 3, line 11 - line 15 column 4, line 53 -column 5, line 30 examples I,II	1-9

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
31 October 2002	12/11/2002

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax (+31-70) 340-3016	RODRIGUEZ FONTAO, M

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Intern[illegible]l application No.
PCT/EP 02/08501

B x l Observati ns where ertain claims were found unsearchabl (Continuation of Item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. [X] Claims Nos.: 11
because they relate to subject matter not required to be searched by this Authority, namely:

Claim 11 relates to useful plants or ornamentals as a product itself. Since acording to Rule 39.1(ii) PCT, no search can be required for subject-matter concerning plant varieties, this claim has not been searched.

2. [ ] Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. [ ] Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. [ ] As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. [ ] As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. [ ] As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. [ ] No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

[ ] The additional search fees were accompanied by the applicant's protest.

[ ] No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP 02/08501

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 2292140 A	14-02-1996	NONE	
US 4676821 A	30-06-1987	NONE	
US 2683658 A	13-07-1954	NONE	